THE USE OF TECHNOLOGY IN AMBULATORY HEALTH CARE*

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How one defines technology depends upon his experience and how he looks at the world. Those involved with machines believe that technology should denote only hardware items, while social planners often extend its meaning to include any application of knowledge. For our purposes, technology may best be considered as any systematic, simplifying, or facilitating approach or device applied to the solution of problems of ambulatory care. This includes machines and physical tools, but also "software"—intellectual tools such as systems analysis, library and record services, aids to education, communication networks, computer-assisted decision-making programs, scientific management systems, and a host of other technics which relate to the care of outpatients. The word technics is used here in Lewis Mumford's sense, to denote all those "things" made and used by technology: e.g., tools, devices, algorithms, systems, and the like.

Technology has revolutionized every field and discipline into which it has been introduced and used extensively; it seems certain that ambulatory care also will be transformed by such involvement. There is good reason to expect a technological implosion in ambulatory care over the next several years, which will radically alter traditional services for the care of outpatients.

Every revolution brings with it problems as well as benefits. Problems can be expected principally in the development, diffusion, and financing of new technics. As in other fields, we can look for three general kinds of benefits: work made easier, increased quality of care, and extension of manpower abilities and limits.

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In one sense medicine has always used technology—it has applied the new discoveries in basic chemical and biological sciences to the care of patients for hundreds of years. Yet it has only recently begun to adopt and apply the breakthroughs in physical sciences and engineering and the advances in management sciences. Hospitals have inherited from the aerospace program and industry a number of technological transfers which have been responsible for the development of elegant devices for monitoring and treatment, automated equipment in clinical laboratories, and computer-controlled hospital-information systems. Yet outpatient services, which are strained by a burgeoning population of patients and by enhanced expectations for care and are hindered by insufficient manpower and organization, have shared in only a few of these advances. Care for the walking patient is by far the more important, for it includes all aspects of out-of-bed health care and does or should involve everyone often as a client.

There are several reasons why technology has not been used more extensively in the care of outpatients.

Lack of available technologies. Relatively few existing technologies are directly applicable to ambulatory care, and some which are available are unproved, offer little hope for significant benefits, and are costly. As a service industry, medicine does not have the same opportunity as a product-oriented industry to utilize automation and the related systemization which increase efficiency.

Disorganization. There has been no coordinating agency to organize technological developments. Communication among those involved in ambulatory care is limited and uncoordinated. Traditionally, health care administrators have been concerned with inpatient hospital services and public health agencies, and are neither trained nor interested in outpatient operations.

Lack of incentives. There are very few reasons compelling the introduction of technology, but many hindrances. Practicing physicians are generally satisfied and very busy in the present system; alteration of present practices will take a large investment of time, effort, and money. Because of the absence of a market competition in medicine, there are few incentives for the use of technology to bring about cost containment. The nation's wealth has permitted the perpetuation of more-of-the-same programs to cover over its growing health problems; wealth is a great impediment to the use of imagination and ingenuity.

There has been little reason for technological entrepreneurs to become involved in this rather highly speculative field. Although certain innovations do offer promise of over-all reductions in costs, some of these savings may diminish the income of physicians and other health providers; it is difficult to be enthusiastic about an innovation that will decrease one's income.

Inadequate time and talent. Health personnel involved in the delivery of care to the walking patient have had little time for thoughtful analysis and experimentation with new devices and systems, and few in this field are prepared by education, training, or experience to innovate or evaluate. Medical schools, the traditional resource for research and for dissemination of knowledge, have had little experience or interest in ambulatory care, have not seen such involvement as their legitimate role, and have found few reasons to become involved.

Legal concerns. Fears about malpractice suits retard introduction of certain technologies, especially those designed for improving the productivity of physicians.

Conservatism. Responsibility for the health and well-being of their patients has bred in physicians a cautious and conservative attitude toward change. The medical profession has had many disappointing experiences with innovations presented with overenthusiasm and with unrealistic promises.

Complexity. Technology is most successful in highly organized situations which require clearly defined, repetitive tasks and simple decisions. The care of patients—especially ambulatory patients—is not like this; they are concerned with an intricate network of interrelated but autonomous subsystems, the inherent complexities of involvement with many ill and irritable clients, and a mix of professionals who function independently. Engineers usually underestimate the complexity of medicine and overestimate their ability to make meaningful contributions. It is clear that the major problems in health care cannot be solved by simplification, but require realistically complex approaches.

Related cultural conditions. The delivery of health care cannot be considered as a separate entity and must be viewed with its interacting environments—social, political, economic, and ecological. Medicine is inextricably related to these environments, and their individual and collective climates will often determine the success of health care innovations.

The unfamiliar. For all its faults, the present system is known and is generally trusted. Confrontation with mechanical equipment and enforcement of new practices in traditional health care settings will cause great unrest among many patients and professionals.

Inertia. Perhaps the most important obstacle of all is the drag which the habits and routines and prejudices of life exert on any attempt at change. Indeed, technology may be introduced more successfully in less developed medical care systems than in well-established, highly developed systems.

Despite these hindrances we can predict with some assurance that technology has a brighter future in outpatient services. There are three harbingers of progress.

1) A few new technologies have been introduced where there was none a few years ago.

2) The pace of research and development in this field has increased markedly. In the past few years several new health care research centers have initiated exciting experimental programs in technology.

3) As the health industry continues to change toward an organized system, opportunities for the use of technology will improve. As any industry grows larger, more complex, and more regulated and, when increased productivity, better record keeping, and communication are required, technology must be used, and used extensively. This has been especially obvious in business, industry, and farming.

In spite of much idle talk and many empty promises, few technologies are really ready now to be applied to health care delivery systems. Many which could be useful are too costly for consideration; others which seem feasible require further development and evaluation.

Perhaps the most immediately useful of those technologies available for outpatient operations are those that can be described as modern management methods. Most outpatient units can benefit greatly by the introduction of proved management methods, supported by well-tested computer services which improve the handling of information, communication, general record keeping, billing, scheduling, and monitoring of resources. These are applicable, with little modification, to the delivery of health care. Although expensive to initiate, this innovation will quickly offer large savings in time and money.

An extension of this approach is the use of industrial and systems-engineering programs which describe in detail the operation of a defined

system and the use of its resources—people, space, equipment, supplies, and money. They offer a much better understanding of the over-all organization with its components, along with interacting groups and agencies with all their complexities. By means of appropriate simulation models, decision-makers in medicine as well as management will be able to make sound operational decisions, anticipate problems and—most important of all—plan ahead on a more secure basis without reliance on intuition and guesses.

Computer diagnosis of the electrocardiogram is now well enough developed to be feasible (at least for screening) and cost-effective, although it has not yet found a wide acceptance. It is the only computer-assisted decision-making project that is ready for general use.

A special word must be said about multiphasic screening (MPS), for this innovation is causing great enthusiasm among health planners but growing disappointment among those involved in its use. Although the basic principles involved have been worked out for selected health care settings such as the Kaiser Health Plan, its use in other settings has not been tested satisfactorily. One reason for dissatisfaction with MPS is the common failure to appreciate that it is not used —or at least should not be used—as a uniform health testing package but must be adapted for various alternative uses: early detection of disease; institutional examinations; an entry to the health systems; a data base for individual medical records (and for establishing more precise and reliable normal ranges for tests); and systematic monitoring of patients with chronic diseases. The major present problems are:

1) There is no satisfying evidence that MPS improves health care.

2) Screening has turned out to be quite unproductive; few abnormalities are discovered in most employed populations.

3) The quality of the tests is often unreliable.

4) Testing is often too costly to be acceptable, and secondary costs are created by the necessity for following-up false positives and the too frequent trivial or untreatable diseases uncovered.

5) The standard test-battery is rigid. Screening must be customized for differences in age, sex, job, and environmental exposures, and for known diseases and abnormal conditions.

6) Many screening units have been isolated from the mainstream of health care; MPS reports are often ignored and the follow-up of abnormalities has been disappointing.

Several technologies seem ready for application in the near future. Computer-assisted history-taking programs are under development in a number of laboratories. Several general medical histories will soon be ready for testing, but usefulness in practice, acceptance by patients and physicians, and cost-effectiveness have yet to be evaluated. Cheaper, more flexible, checklist histories that can be made compatible with computer record-keeping systems are also under development.

Storage and retrieval and transmission of the entire medical record is well within the state-of-the-art of present technology, but the content of the medical record is so disorganized that most investigators feel no real progress can be made until there is radical reorganization of the record itself. The Problem Oriented Medical Record, proposed by Weed and now being rapidly introduced in many parts of the country, is a promising step toward such a reorganization. The computer storage and retrieval of a *working summary* of the medical record, which is being developed in Sweden and in certain laboratories in this country, may be a feasible first step in this complicated field.

Several discrete problem areas in medical decision-making have been organized sufficiently to be "computerized." Computer-assisted diagnosis programs are an exciting prospect for practicing physicians as well as for medical students. These programs will be especially useful to create guidelines for basic decision-making by paramedical health professionals such as nurse practitioners and physician's assistants. Many laboratories are also developing computer-assisted prognosis and treatment programs as well as warning systems for potential side effects of drugs, and drug-disease and drug-drug interactions.

Self-education programs using computer-teaching systems and other audiovisual devices will soon be available for use in the education of patients, new health professionals, and medical students, and in graduate and continuing medical education.

The computer is eminently qualified to serve as a library reference service, but major unanswered questions remain:

1) Of the host of articles and books available, which should be chosen for storage and retrieval by computers?

2) In what form should the information be stored—whole articles, abstracts, or titles only? Although abstracting seems most suitable, most abstracts are not well prepared.

3) Computer terminals for office or home are still very expensive,

although costs are decreasing rapidly as the market continues to expand.

Several interesting and exciting starts have been made in computer-assisted optical scanning of biological cells such as Papanicolaou smears, chromosome preparations, and pathology slides; the automated screening of x rays seems feasible, although farther off.

Teleconsultation service connecting a health center with one or more remote health stations manned by paraprofessionals only is being developed and tested in several locations. This will involve the use of two-way television systems and sophisticated data-transmission and communication devices.

The surge of new technologies will have an impact on many areas. Practicing physicians have been schooled and have grown and developed in practice without the use of much technology. Pressures to utilize technological innovations will be received with enthusiasm by some, but more often with apathy and even antagonism. Successful and satisfied people cannot be expected to change their habits and standard operating procedures without strong incentives. Such innovations may seem threatening to some physicians for a number of reasons; many of these can be countered by education and argument but others, more nebulous and emotionally charged, will be difficult to manage.

Outpatient care is the orphan of medical school services. The faculty for the most part has ignored ambulatory care except for limited involvement in the outpatient clinics of public hospitals. It is clear to everyone who has played a role in such clinics that these services have almost always been outdated and poorly operated, understaffed and badly equipped, and of very limited educational benefit. Research and demonstration in ambulatory care services have started recently in a few medical schools, but many faculty members have still failed to recognize this as a valid involvement for medical schools. Changing these attitudes will be difficult but of prime importance, for medical schools must become involved if we are to accelerate progress in research and development in the technology of health care.

To a large degree, medicine, especially ambulatory medicine, is a social science and an integral part of our culture. Since changes in social systems come about slowly, we must expect a significant lag in the integration of technological innovations in health care. This inherent slowness to change is accentuated by the tide of antitechnology, which is becoming increasingly strong. There is reason for concern that over-

interest in the glamour of new technology will distract us from the subjective, personal aspects of health care that many persons feel are being slighted already.

The economic impact will be great. Start-up costs for new technologies can be expected to be very high, and the expense of operation and maintenance is always greater than planned. As has been the case in every field, technological innovation brings about savings in some areas, but often creates expansion of existing services and demands for new services; this may actually increase the cost of care. Hospitals usually found this true when computer record keeping and elegant monitoring devices were introduced to in-hospital services. Because of their strong management orientation, commercial health corporations, which are growing rapidly in number and influence, will certainly be quick to introduce and use extensively those new technologies which are shown to be useful and feasible. It seems clear that every agency and institution responsible for paying for health services will require proof of cost-effectiveness before accepting new technologies as supportable and reimbursable.

The legal problems attending the use of new health workers and devices will also be significant. The malpractice implications concerning privacy and confidentiality of medical information and the use of (or failure to use) new technics will be of particular importance.

Because it deeply involves the interest of people and groups of all types, the use of technology in health services is inherently a political issue. As federal allocations for research and development in technology grow and federal funds are expended for supporting the use of technology in the delivery of health care, we can expect increasing federal participation in planning, the setting of priorities, evaluation, and the establishment of controls. This new private-public partnership will be difficult to develop. The surrender of independence and cherished prerogatives will be painful for practitioners and administrators in the health system. Whether the government will be content with partnership or will move to dominate remains uncertain and a cause for anxiety.

Administrators and physician-directors who plan to introduce technology into an ambulatory care system—or into any other operation—must beware of several fallacies and fantasies:

Gadgeteering. Buying technology because it exists and may entertain, not because it will be useful. Precious resources should not be

squandered on exciting toys which are of minimal usefulness.

Glamour. Acquiring the latest device just to be fashionable.

Inappropriateness. Looking to technology to answer problems for which it is not suited.

Overbuying. Buying a more sophisticated, powerful, or versatile device or system than is required for anticipated needs.

Blue-sky plans. Long-term, grandiose plans are impractical; short-term, incremental planning is more suited to the circumstances in this rapidly changing field.

Shortcuts and bargains. Developing systems and devices always takes longer and is much more costly than expected. Do not buy a technology unless and until it is proved to be effective for your particular purposes, unless you are prepared to pay the price in time and money for development and testing.

Bigness. Starting off big with large groups of new people and big plans always seems doomed to disappointment and failure. Global systems have global problems.

Underutilization. An elegant machine or system used only a few hours a day can never be justified economically.

Going it alone. Although the prospect of surrendering independence is unattractive to all, involvement in technology in any significant way is almost always best done as a joint effort in order to decrease the cost of start-up and operating expenses, justify a more powerful and sophisticated system or device, provide adequate back-up capability, and improve utilization of equipment and hard-to-get personnel.

Dependence on computers for critical operations. Computers are accident-prone; nothing is as fraught with frustration as an essential system which has been "computerized." A backup capability is mandatory.

Consultants. Inexperienced consultants are extraordinarily naive about the complexity of medicine and the health industry. They often study what is irrelevant and provide unintelligible and useless reports. You must anticipate a long-term involvement between consultants and your research team and practicing physicians. Physicians and medical scientists must learn the consultant's skills and must be trained to continue to use them after the consultant has departed. *You* must define the problems and monitor the progress of the work.

Fly-by-night venders. Many companies are not prepared to fulfill their obligations for design, delivery, and maintenance services.

Overexpectation. This is a new field, full of high hopes and unfulfilled promises. Thus far, the contributions of technology to the solution of problems in health care have been disappointing. Changing the way medicine is delivered is bound to be slow and difficult.

Conclusions

There is growing dissatisfaction on the part of the public, political leaders, third-party payers, and even many providers of health care, because of rapidly rising costs and unsatisfied demands for more and better health services. In the short run, at least, it seems probable that the only hope of containing costs and satisfying these demands is an increased employment of technology and new health professionals.

The basic technical developments required for technological exploitation in the health field are ready and available. They must be adapted for use in ambulatory care and need to be tested and evaluated. Information about those innovations that are proved to be useful and feasible must be disseminated to opinion leaders, to change agents, and thence to private offices, clinics, and health centers, where implementation of these new technics will occur. We can expect a large time-lag between ideas and implementation. These final phases—dissemination and implementation—can be expected to be slow because of the size and complexity of ambulatory care services, the lack of a coordinated promotional program, broad differences in the organizational arrangement of the component services, the wide variety of social and economic settings, and the sluggishness of an established operation unused to change.

In spite of growing concern about the general overuse of technology, the public does appreciate the advances that technology has brought to many other fields, and has accepted well those technics which have already been introduced into health care. There is good reason to believe that the public is ready to accept new technics and indeed, that many leaders will demand that health providers search out ways to bring the advertised miracles of technology to health care. These escalating demands can be expected to be voiced as political pressures and expressed as federal programs of incentives and controls.

With all the present-day problems in ambulatory care, and the anticipated costs and conflicts and frustration which will attend the increased use of technology, it may seem best to many physicians and health administrators to defer involvement in this new venture. None-

theless, there are good reasons to begin involvement now. As the German proverb reminds us: he that thinks it is too soon, is sure to come too late. To prepare to exploit the future opportunities an outpatient organization must be involved with a broad range of technologies over a significant period of time. For most, it will be more expedient to become involved with technology early and develop new programs slowly as new technologies are introduced and evolve, rather than to begin involvement later, when the field has reached greater maturity and complexity. The late introduction of a number of changes into a stable outpatient system may lead to disorganization and disruption. Early involvement will be especially important to the practicing physician, who must learn to adapt his very personalized style of practice to include these innovations. The shock of change will be easier if gradual. The introduction of technology into ambulatory care systems where medical students and house officers are engaged in the care of patients will be difficult, for the intermixing of teaching with service is inherently inefficient and costly. Yet if technology is ever to be integrated effectively into medical practice, physicians must learn to incorporate technology into their patterns of practice during their years of education and training when attitudes and habits are formed.

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